Instructions

SWEEP GENERATOR

TYPE ST-4A

EBI-7008A

GENERAL ELECTRIC

INSTRUCTIONS

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TYPE ST-4A

EBI-7008A

ELECTRONICS DIVISION
GENERAL ELECTRIC COMPANY
ELECTRONICS PARK, SYRACUSE, N. Y.

3/52 (2500)

Printed in U.S.A.

USER WARRANTY

The General Electric Company warrants to the purchaser of the new General Electric Sweep Generator, Type ST-4A, that any part thereof (except electronic tubes incorporated therein which are covered by the company's standard tube warranties) which proves to be defective in material or workmanship within ninety (90) days from the date of original purchase for use, will be repaired or replaced. Any defect of said Sweep Generator, Type ST-4A, should be brought to the attention of the General Electric dealer from whom it was purchased, who shall be authorized to furnish or arrange for repairs or replacements within the terms of this warranty.

The foregoing is in lieu of other warranties, express or implied, and the General Electric Company neither assumes, nor authorizes any person to assume for it, any other obligation or liability in connection with said Sweep Generator, Type ST-4A.

CAUTION

The rear of the case is open for ventilation of the equipment. For this reason, the equipment should <u>not</u> be operated with the back of the case tight to the wall.

NOTE

In later units some changes have been made to compensate for variations in the characteristics of the core of the swept oscillator.

These changes consist of removing R28 (330,000 ohms, 2 watts) and adding R40 (wirewound, 2000 ohms ± 5%, 10 watts; Ward Leonard Cat. #K41382-2; G-E drawing number M-2R12-P84) between the sliding contact of S6 and the junction of C14 and R36.

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These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or particular problems arise which are not sufficiently covered for the purchaser's purposes, the matter should be referred to the General Electric Co.

SWEEP GENERATOR

TYPE ST-4A

DESCRIPTION

The General Electric Sweep Generator, Type ST-4-A, is a high quality instrument designed to produce an exceptionally wide, linear sweep for use in developmental laboratories, television and FM radio servicing, production line testing, and educational laboratories.

The linear sweep is produced electronically and therefore requires no moving parts. A 6J6 oscillator has its coil wound around a powdered iron core placed between the poles of a laminated iron reactor. The reactor has 60-cycle voltage applied to its winding, and the resulting flux varies permeability of the powdered iron core. Thus the oscillator output is swept back and forth at power line frequency. Sweeps of from 500 kc to more than 15 mc are available by applying more voltage from the transformer secondary to the reactor winding with the SWEEP WIDTH switch.

The high-frequency band (170 to 220 mc) is covered by the swept oscillator alone, providing a maximum output of at least 0.5 volts. The oscillator output is fed to a mixer tube and hence to the RF attenuator network.

The lower RF band (60-110 mc) and intermediate frequencies are covered by beating one oscillator against the other, which is tuned to a definite frequency. Both oscillator outputs are fed to the mixer tube and the difference frequencies of 4 to 110 mc appear at the output jacks for use. In this range the maximum voltage is at least 0.1 volt. A removable filter is included for use at the lower frequencies to attenuate unwanted high frequencies.

There is approximately 1 volt of unmodulated RF available at the X1 jack over the 220 to 275 mc band. This is obtained by turning the SWEPT OSC and BLANKING OFF, and tuning the BEAT OSC to the desired frequency.

The output attenuator is in five steps with a vernier control located at the terminal end of the RF output cable. This arrangement allows complete control from maximum output to below 20 microvolts.

A phasing control is provided on the horizontal sweep output for the oscilloscope. The sweep voltage is taken from a separate winding on the power transformer and fed through a network circuit with double controls that provide more than 180 degrees of phase shift. A PHASE REVERSAL switch allows a total phase shift of more than 360 degrees for complete flexibility.

The equipment is completely enclosed in double metallic shielding with double filters on all leads entering the oscillator compartment.

Thus, the leakage is kept to a value that allows observation of response of the most sensitive television receiver, set at maximum gain, without overloading.

The ST-4A Sweep Generator is housed in a gray, wrinkle finished case with a satin aluminum panel, slotted for mounting in a standard 19-inch relay rack. When rack mounted, the leakage is not increased as the case does not form part of the shielding.

The generator is furnished complete with output cable and output filter.

The 300-ohm Balanced Output Adapter, Type ST-8A, is available at a small extra charge. This unit matches the generator output to the 300-ohm balanced input of a television receiver.

TECHNICAL SUMMARY

1. ELECTRICAL

Frequency Range:	Continuously variable from 4 to 110 mc and 170 to 220 mc in two bands.
Sweep Width:	Linear from 500 kc to more than 15 mc.
Output Voltage:	Greater than 0.1 volt from 4 to 110 mc. Greater than 0.5 volt from 170 to 220 mc. Approximately 1 volt from 220 to 275 mc.*
Amplitude Modulation:	Less than 0.1 db/mc sweep.
Output Attenuation:	Continuously variable from maximum to 20 microvolts.
Leakage:	Stray fields less than 10 microvolts as measured by a 2-inch pickup loop 6 inches from the case in any direction.
Output Impedance:	20 to 70 ohms, depending on setting of the attenuator.
Phase Control Range:	Greater than 360 degrees.
Ambient Range:	0 to 40 degrees centigrade.
Power Requirement:	105-125 volts, 50-60 cycles, 100 watts. Power transformer has a double primary and can be wired for operation on 210-250 volts, 50-60 cycle power.
Tube Complement:	3 Type 6J6 1 Type 5Y3GT

*This is unmodulated output. The SWEPT OSC and BLANKING should be OFF.

2. MECHANICAL

Height:	10-3/4 inches
Width:	19-1/4 inches
Depth:	10 inches
Weight:	30 pounds

NOTE

The front panel is slotted for mounting in a standard 19-inch relay rack mount. (Panel dimensions: 10-1/2 by 19 inches.)

SERVICE PARTS AND ACCESSORIES

1. SERVICE PARTS FURNISHED

Tube Complement
RF Output Cable
Filter Unit (used with IF outputs)

2. ACCESSORIES FOR TELEVISION AND FM SERVICING

(These are recommended for use with the ST-4A Sweep Generator, but must be purchased separately.)

Type ST-8A Balanced Output Adaptor
Type ST-5A Marker Generator
Type ST-2A Oscilloscope

CIRCUIT DESCRIPTION

The General Electric Sweep Generator, Type ST-4A employs two oscillators, a mixer tube, and the associated power supply in a completely flexible circuit to produce a variable, wide linear sweep output for the analysis and alignment of video type amplifiers. Their relationship may be seen by reference to the Block Diagram, Fig. 1.

1. SWEPT OSCILLATOR, V1

This circuit is a 6J6 dual triode with both sections paralleled as a modified Colpitts oscillator tuneable through a range of 170 to 220 mc. (See Elementary Diagram, Fig. 28). The oscillator tank coil (L4) is wound around a powdered iron core which is mounted in the magnetic field of reactor L1. Sixty-cycle voltage is applied to L1 producing a flux of sine waveform to saturate the iron core. Therefore, the frequency of the SWEPT OSC is varied with the permeability of the iron core of L4. A series of voltage taps from the secondary of the power transformer allows the

operator to select several widths of sweep output with the SWEEP WIDTH switch (S6). Available sweep widths are listed in the following table. The output of V1 is fed to pin 6 of V2, mixer tube.

Sweep Width Control	Approximate Width
Position 0*	0
1	500 kc
2	2 mc
3	4.5 mc
4	9 mc
5	14 mc
6	19 mc

2. BEAT OSCILLATOR, V3

This oscillator is also a 6J6 wired as a modification of the Colpitts circuit, tuneable from 220 through 275 mc. Its operating frequency range is inscribed on the inner calibrated band of the INTERMEDIATE FREQ dial. Its output is fed to pin 5 of the mixer tube (V2).

The BEAT OSC, BANDS 2 & 3 switch controls the application of plate voltage to V3, hence, allowing complete shut down when the high-frequency range is being used.

3. MIXER CIRCUIT, V2

The mixer circuit is a 6J6 dual triode with plates and cathodes common. The outputs of the swept oscillator (V1) and the beat oscillator (V3) are fed to the two control grids. The combined output appears across the plate load and is fed to the output attenuator. The SWEPT OSC switch (S2) allows removal of plate voltage from both V1 and V2 when desired.

There is a small amount of amplitude modulation present in the output of the swept oscillator which would cause the oscilloscope curve to vary in amplitude. The transformer T2 and the phasing network R37, R38, R39, C28 introduce the proper amount of out-of-phase voltage to cancel this unwanted modulation.

4. OUTPUT ATTENUATOR

The output attenuator is a ladder type circuit allowing output attenuations of X1, X.1, X.01, X.001, and X.0001 at impedances vary from 20 to 70 ohms depending upon the setting of the RF output control (R30) that terminates the RF output cable. Smooth output control is positive to below 20 microvolts, and the stray leakage is extremely low.

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*Maximum counterclockwise.

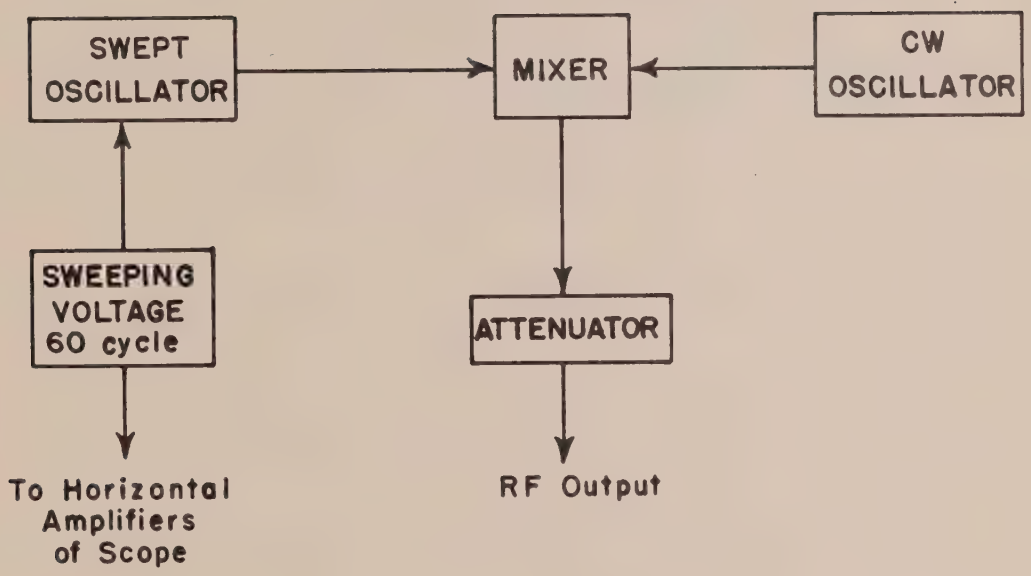


Fig. 1 Block Diagram of Sweep Generator

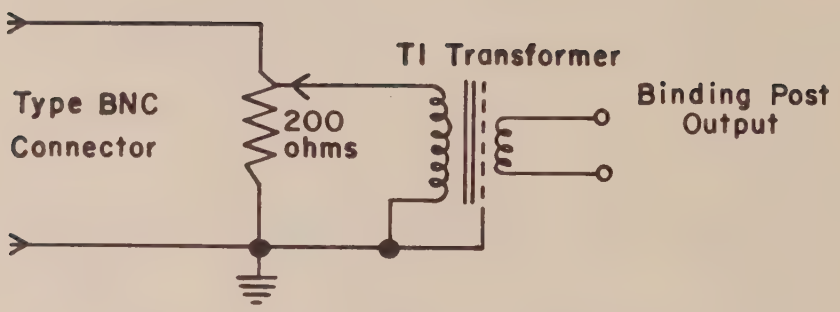
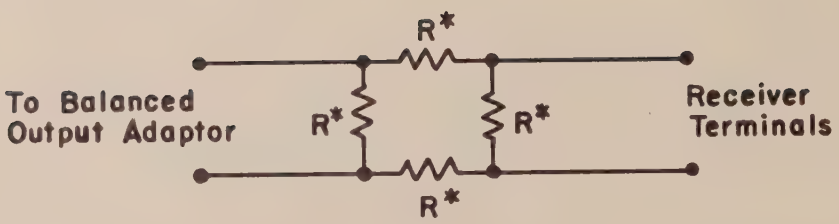


Fig. 2 Circuit Diagram, Balanced Output Adaptor, Type ST-8A



*R is a 430 ohm, 1/2 watt resistor. They are soldered to form as small a square as possible

Fig. 3 Recommended Matching Pad for ST-8A Adaptor

5. OUTPUT FILTER

An output filter is included that acts as a low pass filter attenuating the unwanted oscillator fundamentals during operation at the intermediate frequencies.

6. BALANCED OUTPUT ADAPTOR, TYPE ST-8A

This Balanced Output Adaptor, Type ST-8A, has been designed for use with the General Electric ST-4A Sweep Generator. The ST-4A Sweep Generator normally has single ended output and with the addition of the Adaptor, balanced output is available. The Adaptor has been designed to give flat output when working into a 300-ohm resistive load. The characteristics of the Adaptor may vary widely if the load is greatly different from 300 ohms.

The Circuit Diagram of the Adaptor is shown on Fig. 2.

The vernier output control of the Sweep Generator is normally incorporated in the output cable. When using balanced output, the vernier control is incorporated in the Adaptor.

In view of the fact that many nominally 300-ohm input receivers may vary over a ten-to-one impedance range as they are tuned through the twelve channels a pad is recommended for use with the Adaptor (Fig. 3).

300-ohm twin lead should be used to connect from the adaptor to the pad. The pad should be located as close to the receiver antenna terminals as possible.

7. BLANKING

A voltage pulse from the phasing network C13, R28 is fed to the grid of the swept oscillator (V1) which cuts off the tube during the return sweep. The return trace on the oscilloscope is therefore at zero level and can be used as a reference base line. The germanium diode (XTAL 1) is used to improve the shape of the blanking pulse to V1.

8. PHASING CONTROLS

The horizontal sweep output for the display oscilloscope is taken from a separate center tapped winding on the power transformer. It is fed through a double pole, double throw switch wired to reverse the phase of the windings 180 degrees. The voltage is then applied to the phasing controls (R25A and B) which allow the output phase to be shifted more than 180 degrees. Therefore, it is possible to control a phase shift of more than 360 degrees on the horizontal sweep output voltage.

9. POWER SUPPLY

The power supply of the ST-4A Sweep Generator is a conventional full wave rectifier circuit employing a 5Y3GT tube and an output filter composed of C15A and B, and R27.

The transformer has taps on the high-voltage secondary winding to feed the sweep width. The primary is composed of two windings to allow 105-125 volts or 210-250 volts operation (See MAINTENANCE section for connections).

OPERATION

1. CONTROLS (See Fig. 4)

A. SWEEP WIDTH Control (S6)

Located in the upper left hand corner of the panel is a 7-position switch that provides 6 different a-c voltages for application to the sweep reactor (L4) of the swept oscillator tube (V1). These voltages are supplied from taps on the secondary of the power transformer (See Elementary Diagram, Fig. 28 for voltages). The first position of the switch is an OFF position to provide zero sweep width.

Switch Position	Approximate Width
0*	0
1	500 kc
2	2 mc
3	4.5 mc
4	9 mc
5	14 mc
6	19 mc

B. SWEPT OSC ALL BANDS (S2)

Switch S2 is located to the right of the pilot light on the front panel. It is a single pole, single throw toggle switch in the B+ circuit of the swept oscillator tube (V1) and mixer tube (V2). When turned to OFF, plate voltage is removed from V1 and V2, placing them on standby.

C. POWER Switch (S4)

Switch S4 is found in the lower left corner of the panel. It is a single pole, single throw switch wired into the primary of the power transformer (T1).

*Position 0 is a maximum counterclockwise.

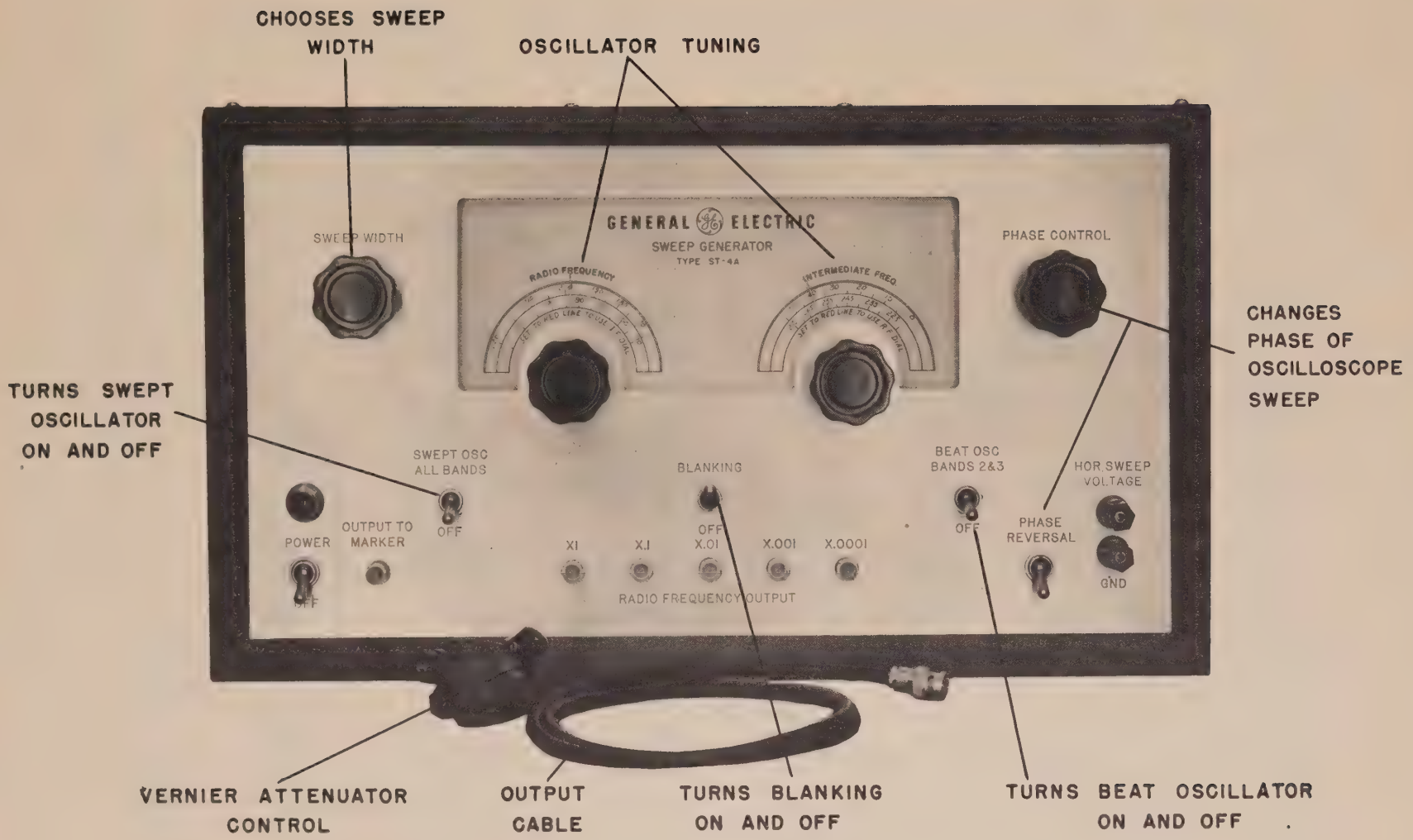


Fig. 4 Front Panel of ST-4A Sweep Generator

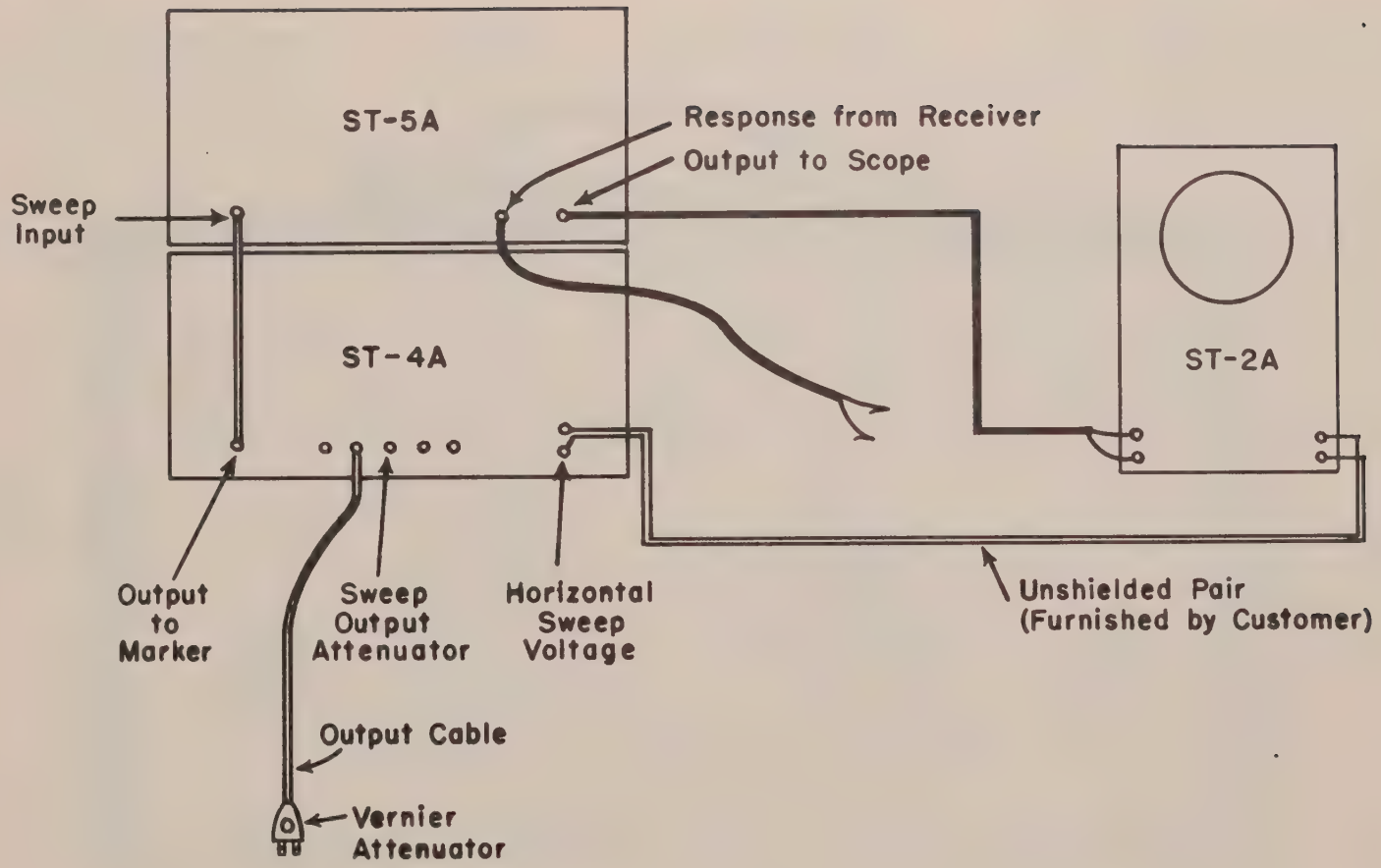


Fig. 5 Interconnection Diagram of Sweep Generator, Marker Generator, and Oscilloscope

D. SWEPT OSC Tuning Control (C1)

This control is located to the right of the SWEEP WIDTH control, and varies the tuning capacitor (C1) of the swept oscillator circuit (V1). It is used to change frequency of the upper RF band (170-220 mc).

E. BLANKING Switch (S1)

Switch S1 is located in the center of the operating panel. It is a single pole, single throw switch wired in the grid circuit of the swept oscillator (V1). It feeds a shaped 60-cycle signal from the phase network C13, R28 to blank out the swept oscillator during the return trace time.

F. BEAT OSC Tuning Control (C7)

This control varies the tuning capacitor of the beat oscillator (V3). It varies the frequency of bands 2 and 3 output.

G. BEAT OSC BANDS 2 & 3 Switch (S3)

This is a single throw, toggle switch wired into the plate circuit of the beat oscillator tube (V3). It removes B+ from the beat oscillator tube when turned to OFF.

H. PHASE CONTROL (R25A,B)

This control is located in the upper right corner of the panel. It is a twin 100,000-ohm potentiometer assembly. Each potentiometer is independently operated by concentric shafts. R25B (outer control) furnishes about 170 degrees of phase rotation, while R25A (inner knob) produces the rest of the 180 degrees rotation.

I. PHASE REVERSAL Switch (S5)

S5 is a double pole, double throw toggle switch wired into the horizontal sweep voltage circuit to allow reversal of the transformer windings of the phaser circuit. Thus the combination of the phasing controls (R25A and B) and the PHASE REVERSAL switch (S5) allows more than 360 degrees of phase rotation.

J. Decade Attenuator

This terminates in the 5 output jacks located on the lower center of the panel. The output is available in the following decade steps X1, X.1, X.01, X.001, and X.0001.

K. RF Output Attenuator (R30)

R30 is a 200-ohm potentiometer mounted in the terminal box at the end of the RF output cable. It is used to reduce the output of the generator between steps of the RF attenuator.

L. Balanced Output Adaptor, Type ST-8A

The 300-ohm Balanced Output Adaptor makes available 300-ohm balanced output. It contains its own output attenuator for reduction of generator output. Connection between the receiver and the adaptor should be standard 300-ohm cable. See Figs. 2 and 3.

ALIGNMENT OF TELEVISION RECEIVERS

The alignment of a television receiver presents a complex problem to the service man. Numerous interacting circuits must be precisely tuned to specified frequencies in order to assure good picture reception. In addition, the band pass of the receiver must be wide, and the gain uniform over a band width of several megacycles.

Since each make and model of television receiver has peculiarities inherent in its design, the exact sequence of adjustment will have to be determined from the manufacturers service notes of the particular equipment. If the receiver is a combination type with broadcast, short wave, and FM sections, these circuits are aligned before the television section is considered.

1. SETTING UP THE SWEEP AND MARKER GENERATORS FOR OPERATION

The ST-4A Sweep Generator, ST-5A Marker Generator, and the Oscilloscope are set up and cabled together as shown on Fig. 5. All necessary cables have been furnished with the equipment with the exception of the cable from the horizontal output of the Sweep Generator to the horizontal input of the Oscilloscope. Since this requires no special shielding it was omitted to allow the user greater flexibility of installation.

After installation of the equipment the power should be turned on to allow the instruments to reach stable operating temperature. During this period the operator can check the instruments for operation. A rapid check can be made as follows:

A. Set Oscilloscope Controls

1) Centering as needed.

2) Intensity and focus as needed.

3) Vertical gain as needed.

4) Horizontal selector switch to horizontal input.

5) Horizontal gain as needed.

B. Set ST-4A Sweep Generator Controls

1) SWEPT OSC on.

2) BEAT OSC OFF.

3) Tune SWEPT OSC to 200 mc.

4) Turn SWEEP WIDTH maximum counterclockwise.

C. Set ST-5A Marker Generator Controls

1) PICTURE CARRIER switch to 37-50 mc.

2) PICTURE CARRIER ON-OFF switch to ON.

3) CRYSTAL MODULATOR to OFF.

4) MARKER SIZE control to mid position.

5) Tune to 50 mc.

If the Sweep and Marker Generators are operating, a large deflection will show on the Oscilloscope as the Sweep Generator is tuned through 200 mc. This is a beat between 200 mc Sweep and 50 mc Marker outputs.

By reference to the following two tables, control settings can be made for any desired output.

SETTING THE ST-4A SWEEP GENERATOR CONTROLS

NOTE: SWEPT OSC switch and BLANKING switch* are ON at all frequencies.

Desired** Frequency	Beat Oscillator Switch	Radio Frequency Dial	Intermediate Freq Dial	Sweep Width	Remarks
4.5 mc	On	To Red Line	4.5 on scale	2 mc	See Fig. 5 for markers.
10.7 mc	On	To Red Line	10.7 on scale	2 mc	See Fig. 5 for markers. Adjust phase controls.
21.9 mc	On	To Red Line	21.9 on scale	2 mc	See Fig. 5 for markers. Adjust phase controls.
23 mc	On	To Red Line	23 on scale	Max.	See Fig. 5 for markers. Adjust phase controls.
57 mc (Channel 2)	On	Inner scale to red 2	To Red Line	Max.	See Fig. 5 for markers. Adjust phase controls.
43 mc	On	To Red Line	43 on scale	2 mc	See Fig. 5.
46 mc	On	To Red Line	46	2 mc	See Fig. 5.
88 mc	On	88 mc	To Red Line	2 mc	See Fig. 5.
98	On	98 mc	To Red Line	2 mc	See Fig. 5.
108 mc	On	108 mc	To Red Line	2 mc	See Fig. 5.
177 mc (Channel 7)	Off	177 mc	To Red Line	Max.	See Fig. 5.

*The Blanking should be turned off to adjust the Phasing Controls for overlap, then switched on.

**On all frequencies using the Beat Oscillator, use the output filter provided.

SETTING THE CONTROLS OF THE ST-5A MARKER GENERATOR

Desired Marker	Band Selector Switch	Picture Carrier Switch	Crystal Modulator Selector	Crystal Modulator Switch	Remarks
4.5	--	Off	Audio Carrier 4.5	On	The Marker size varied by MARKER SIZE control.
10.7	20-27	On	Dial Calibrate	On*	Tune to 21.4 mc. on dial. Calibrate at 22.5 mc.
21.9	20-27	On	Dial Calibrate	On*	Tune to 21.4 mc. on dial. Calibrate at 22.5 mc.
26.4	20-27	On	Dial Calibrate	On*	Calibrate at 27 mc.
Ch. 2	Ch. 2	On	Audio Carrier 4.5	Off	Turn CRYSTAL MODULATOR switch ON when audio carrier marker is needed.
Adj Channel	Desired Channel	On	Adj Channel 1.5	On	Turning CRYSTAL switch ON adds markers at 1.5 mc intervals to check ADJ CHANNEL.
43	37-50 mc	On	Dial Calibrate	On*	
46	37-50 mc	On	Dial Calibrate	On*	
88	37-50 mc	On	Dial Calibrate	On*	Tune to 44 mc. This is a second harmonic.
98	37-50 mc	On	Dial Calibrate	On*	Tune to 49 mc.
108	27-37 mc	On	Dial Calibrate	On*	Tune to 36 mc. This is a third harmonic marker pip.
177 (Ch. 7)	Ch. 7	On	Audio Carrier 4.5	Off	Turn ON the CRYSTAL MODULATOR switch when Audio Carrier markers are wanted.

*Switch turned off after calibration.

2. CALIBRATION OF THE TUNEABLE RANGES OF THE ST-5A MARKER GENERATOR

NOTE

For completely stable operation of the Marker Generator, it should be warmed up for a period of at least thirty minutes.

A. Calibration at 27 mc

1) Marker Generator output connected to an Oscilloscope.

2) PICTURE CARRIER selector switch to 19-27 mc.

3) PICTURE CARRIER to on.

4) MARKER SIZE control as needed.

5) CRYSTAL MODULATOR selector switch to DIAL CALIBRATE 4.5 mc.

6) CRYSTAL MODULATOR switch to on.

7) Oscilloscope VERTICAL GAIN as needed.

8) Tune output of the tuneable PICTURE CARRIER oscillator for zero beat with the sixth harmonic of the 4.5 mc crystal oscillator (27 mc). Leave the TUNING control in this position. Move dial mechanically with the ADJUST DIAL control so that 27 on the dial matches the pointer position. This matches the upper portion of the dial for very accurate reading.

B. The calibration points on the three ranges of the tuneable bands are marked on the dial with red dots. They are as follows:

20.25 mc*	
22.5 mc	36.0 mc
27.0 mc	40.5 mc
31.5 mc	49.5 mc

3. SPURIOUS OUTPUTS OF SWEEP GENERATOR

There are two spurious outputs which are not attenuated by the output filter. One is caused by the second harmonic of the desired output beating against the CW oscillator. It is visible in the vicinity of channel 6 and has an amplitude of about 10 percent of the desired signal. A numerical example should serve to clarify this matter. At 92 mc desired output frequency from the Sweep Generator the CW oscillator is operating at 275 mc.

*This one is rather weak (turn up Marker SIZE control). The calibration procedure outlined in A is followed in each case.

92 mc x 2 = 184 mc

275 - 184 = 91 mc

92 mc = Desired output frequency

275 mc = CW oscillator frequency

184 mc = Second harmonic of desired output

91 mc = Spurious output frequency

This can be eliminated by moving both the swept and CW oscillators lower in frequency, but keeping the difference the same. The spurious will move off the end of the trace as this adjustment is made. Many owners of this equipment have never even seen this spurious output, but it is being mentioned here for the benefit of those who may be puzzled by it.

The second spurious referred to is caused by the third harmonic of the desired output beating against the CW oscillator and occurs around channel 4. This one is so small that no user has ever reported being troubled by it or even seeing it. It can be eliminated by the same procedure mentioned for the second harmonic interference.

4. ALIGNMENT SEQUENCE

Broadly speaking there are two major types of receivers to be considered.

A. Conventional - Separate Sound And Video IF.

In general, the following sequence covers the alignment of conventional receivers:

1) Sound IF.

2) Sound and adjacent channel traps.

3) Video IF.

4) 4.5 mc sound trap (if used).

5) Front end.

B. Intercarrier Sound Receivers.

Intercarrier receivers usually follow these steps in alignment:

1) Sound IF.

2) Video IF.

3) Adjacent channel traps (if used).

4) Sound traps (if used).

5) Front end.

Experience has shown that it is very rare for a receiver to need complete realignment. Sections that have been serviced must be brought into alignment, of course, but a quick over-all check will usually show that a touch up of one or two traps or over-all IF is all that is required for the average service job.

The usual symptoms of a poor trap alignment in a conventional receiver are:

A. Weak or distorted sound.

B. Sound bars in the picture.

C. Fine grains in the picture.

D. Poor picture detail.

The most critical adjustment of an intercarrier set is the secondary adjustment of the ratio detector. If this is not properly adjusted, the amplitude modulation on the 4.5 mc sound will not be completely removed, causing a buzz in the audio output. This is because the amplitude modulation is the picture frame frequency of 60 cps.

Poor front end alignment is shown, in both set types, by poor picture detail or poor sensitivity. However, because of broad response circuits RF alignment can be off considerably without appreciably affecting the receiver performance. If the local oscillator is out, it may be impossible to tune in the picture or sound.

In many instances, defective tubes or poor antenna installations will cause symptoms identical to poor RF or IF alignment. A service man should always investigate these possibilities before judging that poor alignment is the cause of the trouble.

5. GENERAL ALIGNMENT PRECAUTIONS

A. When servicing receivers with transformerless power supplies, always use an isolation transformer at the receiver power input to prevent injury to personnel or test equipment.

B. Be sure the receiver is in good operating condition other than alignment.

C. Always follow the manufacturer's alignment instructions covering special peculiarities.

D. Set all controls at their recommended operating positions.

E. Always allow test equipment and receiver to warm up for at least 15 minutes before starting the alignment.

F. Always use proper alignment tools as recommended.

G. Do not force adjustments locked with cement - loosen with solvent.

H. Terminate the generator output properly. For input to 300-ohm antenna terminals use the 300-ohm Adaptor, ST-8A, with recommended pad for best results. (See Fig. 3.)

I. Make all leads short. Follow manufacturer's instructions for grounding points; otherwise make ground leads as short as possible. Keep leads as far as feasible away from adjacent circuits.

J. Remember 20 and 40 mc IF are very critical as to lead dress, isolation resistors, etc.

K. When aligning IF's, be sure front end is not influencing the curve. Turn head end to a non-interfering channel.

L. Do not overload the circuit with too much signal; if in doubt, reduce the generator output slightly. The curve should reduce in height without changing shape. Overloading may be avoided by following the manufacturer's recommendation regarding signal output at the detector (usually in the neighborhood of 1 to 3 volts peak-to-peak). In other words, the sweep generator output is varied at each step of alignment to give the same size response curve on the oscilloscope. If this plan is followed, the gain of the scope must be set (calibrated) for the recommended peak-to-peak voltage and left constant.

6. ALIGNMENT SUGGESTIONS

A. If the response curve jitters vertically, it is probably caused by the feed through of vertical scanning frequency. This can be stopped by temporarily pulling the vertical oscillator tube (unless it is a series filament model), or adjusting frequency with the vertical hold control.

B. Occasionally, the response on the oscilloscope is muddy or indistinct. This is due to the feeding through of the horizontal scanning frequency of 15.75 kc. Here again the remedy is disabling the oscillator. It is generally not a good idea to remove the oscillator tube, because it may remove bias on the horizontal output tube. Also this bias is sometimes used in the RF and IF tubes. Consult the manufacturer's note on this.

C. Improper termination or grounding shows up as standing waves on the generator cables. If grasping the cables changes the curve shape this must be corrected before alignment is started. Change the terminating resistance accordingly and shorten the ground leads if possible. (See page 5, section 6.)

D. Most service notes take the video response across the load resistor of the detector. If the oscilloscope is too insensitive, output can be taken from one of the following video amplifier stages. Remember that the polarity changes for each stage passed through. Thus, the first video stage output is 180 degrees out of phase with the detector, and the second stage output is in phase with the detector. If the video amplifier has low-frequency phase shift, the response curve will tilt to one side. This effect may change the curve too much for alignment useage.

E. The vertical amplifiers of an oscilloscope are easily calibrated. In the case of the General Electric ST-2A, calibrating voltage is fed from the panel jack to the input with the lead provided. The calibration switch selects the desired peak-to-peak output, and the gain control is set to give the desired picture height.

To calibrate other oscilloscopes, the serviceman must have a source of variable a-c voltage and an accurate meter. See Fig. 6.

Turn the oscilloscope gain to zero and set the voltage to the correct voltage on the meter. Turn up the gain on the vertical amplifier to get the desired picture height. Do not touch the gain after this is done. Don't forget the meter reads RMS volts, not peak-to-peak. Use the formula below to convert voltages.

Desired peak to peak voltage X.35 = meter reading.

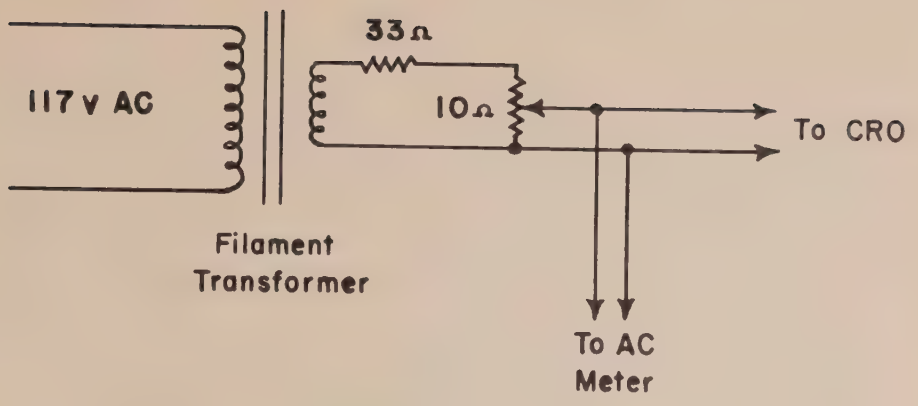
7. ALIGNMENT PROCEDURES

Almost all conventional type television receivers are aligned in a manner similiar to that shown on Figs. 7 and 8. Suppose the receiver IF responds to a 26.3 mc picture carrier and a 21.8 mc sound carrier, and a 4.5 mc sound IF.

A. Sound IF Adjustment

For sound adjustment, the Sweep Generator is set up with an approximate center frequency of 4.5 mc and a sweep width of 2 mc (position 2). The receiver output is taken from the discriminator output. The Marker Generator is set for 4.5 mc output from the crystal. The sweep input is connected to the limiter control grid and the generator output is adjusted to give the correct size picture on the calibrated oscilloscope. The discriminator primary is adjusted to give maximum output and the cross-over is set with the 4.5 mc marker at the correct point as shown on Fig. 19.

After discriminator adjustment, the receiver response cable is moved to the limiter grid and the sweep generator output is fed to the sound IF grid. The transformer is adjusted for a typical IF response curve with the 4.5 mc marker centered. The generator output is moved back stage by stage until all sound IF's are aligned.



Desired Peak-to-Peak Reading X 0.35 = Meter Reading

Fig. 6 Calibration Circuit for Oscilloscope

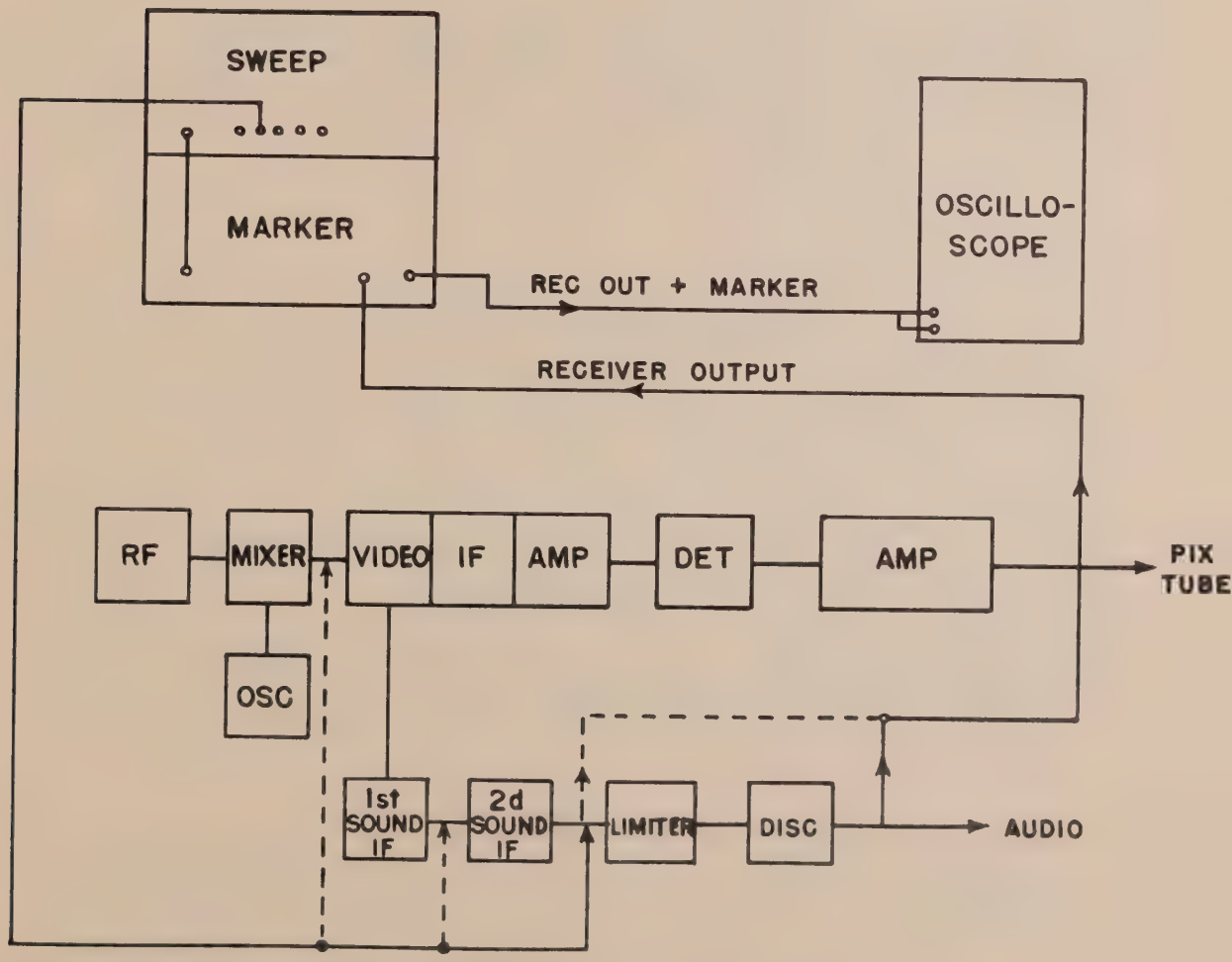


Fig. 7 Sound IF Alignment

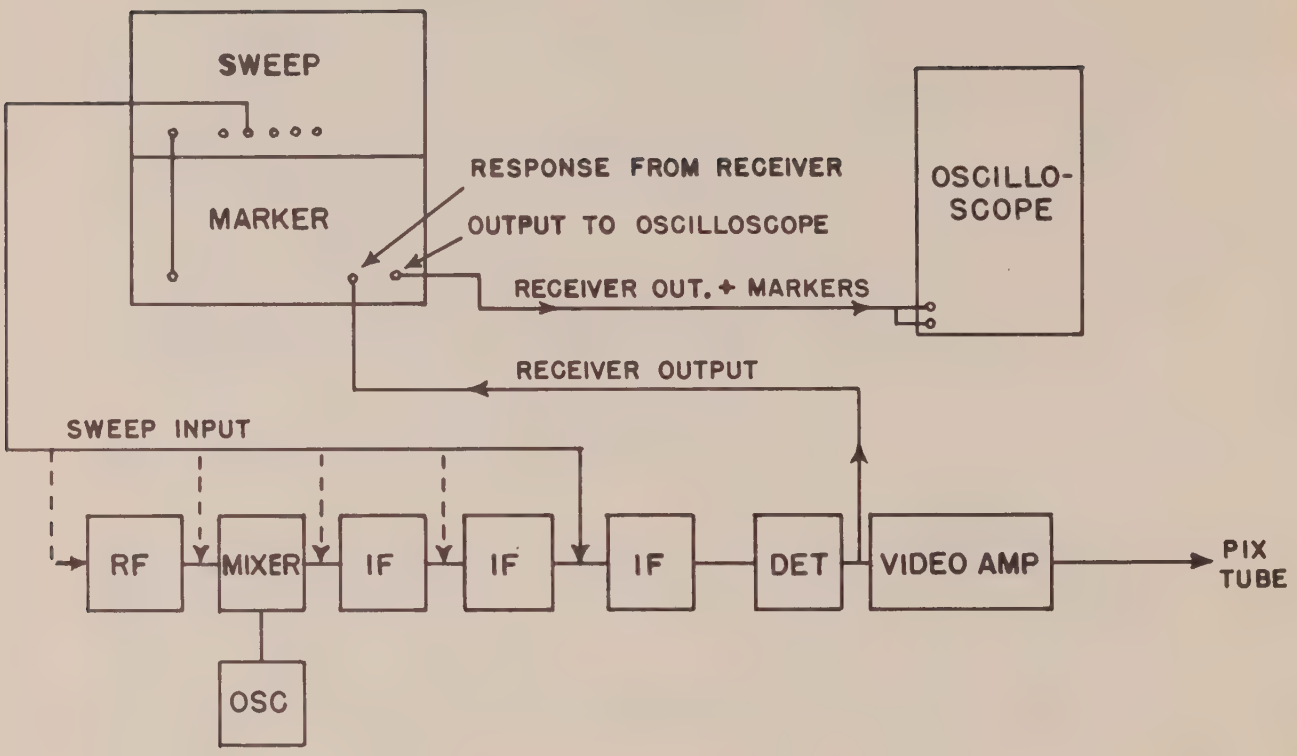


Fig. 8 Video IF Alignment

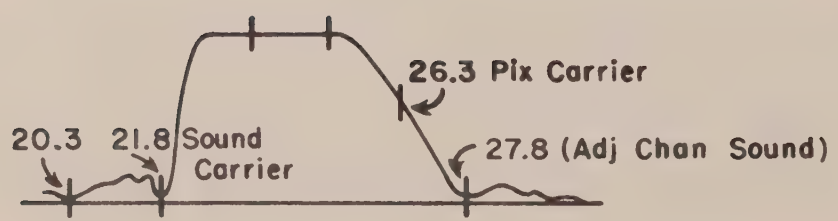


Fig. 9 Adjacent Channel Traps

At this point the sweep generator output is connected to the 1st video IF grid and set to 21.8 mc center frequency with 2 mc sweep width. The Marker Generator is set at 21.8 mc after scale calibration with the crystal. The sound takeoff trap is adjusted for maximum response and a centered marker. This completes the sound IF alignment.

B. Video IF adjustment

The next step is the video IF adjustment. Referring to Fig. 8, the receiver output is shifted to the video detector output and the sweep generator is moved to the last video IF grid, and is retuned to a center frequency of 25 mc with a sweep width of 10 mc.

The video stages are aligned step by step, leaving the output to the scope at the picture detector. By comparison with the published curves the serviceman can note the effect of each additional stage.

Sound traps in the video IF stages can be adjusted along with the regular alignment by turning on the audio carrier marker, and tuning the trap so that the circuit response is at a minimum at the audio marker, as shown on Fig. 9. Adjacent channel traps are tuned in the same manner as the sound traps, using the 1.5 mc adjacent channel marker. Over-all bandwidth can also be checked at this time with the 1.5 mc markers.

C. CW Signal For Aligning Traps and Stagger Tuned IF's

Most users think that an additional AM generator is necessary for aligning some TV receivers when service notes call for a CW or AM signal and a VTVM. They do not realize that if they reduce the sweep width to zero, the ST-4A Sweep Generator puts out an essentially CW signal. The ST-5A Marker Generator can be tuned to beat with it and thereby indicate the frequency of the CW signal from the sweep. If the sweep BLANKING switch is ON, the ST-2A scope will function the same as d-c VTVM. Two horizontal lines will show on the face of the scope, one line indicates zero output from the circuit being aligned, the other line indicating the magnitude of the output from the circuit. The only signal we cannot get is an amplitude modulated signal.* However, when using G-E equipment we have never been able to demonstrate any particular need for an AM signal. Although this technique using the sweep as a CW generator and the scope as a VTVM is somewhat unusual, it will amply repay a person for a little time spent in learning it. The reason being that it allows both sweep and CW alignment methods to be used as circuit conditions dictate without having to connect and disconnect various pieces of equipment.

*Actually when operating the sweep as a CW generator with blanking ON, we have a 100 percent amplitude modulated signal; the modulation being a 60-cycle square wave. It is this square wave (ON-OFF) signal that allows the oscilloscope to indicate as a vacuum tube voltmeter.

Two examples are given:

1) Trap Adjustment

While aligning a video IF it is felt that a CW signal is needed for adjustment of an adjacent channel trap at 47.25 mc. Presumably the picture carrier marker has been set at 45.75 mc and 1.5 mc side band markers are being used, the first marker higher in frequency than the picture carrier is the adjacent channel at 47.25 mc (see Fig. 10). To align the trap with a CW signal just tune the Sweep Generator higher in frequency so as to move the adjacent channel to the approximate center of the scope. (See Fig. 11.) Now reduce sweep width with the sweep tuning keeping the adjacent channel centered. (See Fig. 12.) When the sweep width has been reduced to zero there will probably be a straight line with a superimposed audio beat showing on the scope. (See Fig. 13.) Reduce marker size until the beat almost disappears.

Now increase the output from the sweep generator until two horizontal lines show on the scope. (See Fig. 14.) Tune the adjacent channel trap for minimum distance between the two lines, if they superimpose again increase the output from the sweep and continue tuning the trap for minimum. (See Fig. 15.) After the trap is adjusted the sweep generator output should be reduced to normal, the sweep width returned to normal and the IF curve recentered. A word of warning: resist the tendency to control response curve height with the scope's gain control. Set it up as specified by the receiver manufacturer and control response curve height with the sweep generator output attenuator.

2) Stagger Tuned IF Stages

Stagger tuned IF's generally do not require complete realignment, usually all that is needed is to connect the sweep to the converter grid, insert the desired markers and, using the Service Notes as a guide, touch up the IF's over-all. There are, however, times when a stage by stage procedure is necessary. Here we use the sweep as a CW generator and the marker's tunable oscillator without side band markers. Set the markers to the frequency indicated by the manufacturer for the particular stage. Tune the sweep to beat with it. The scope indication should be similar to Fig. 15. Tune the IF stage for maximum distance between the horizontal lines, if they go off-screen reduce the sweep generator output and continue peaking the stage, at maximum the indication should be similar to Fig. 14.

It can be seen from the above that without tieing up additional equipment we can use either CW generator and VTVM techniques or sweep and scope methods.

A note in connection with using the sweep as a CW generator. At zero sweep the scope pattern will usually show a sideway jitter due to the fact that the line voltage kicks will cause the oscillation to shift slightly. This is generally so slight a percentage of the operating frequency that it is of no consequence.

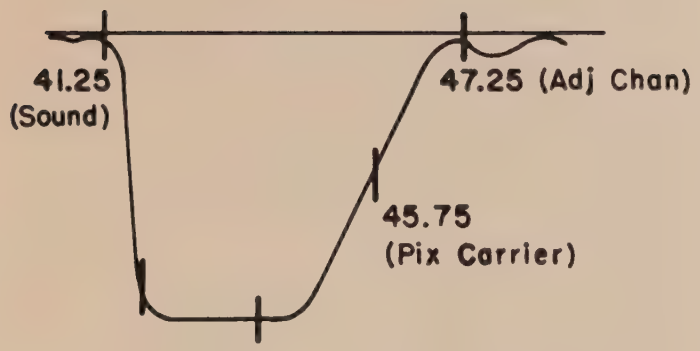


Fig. 10 Trap Alignment, Step 1

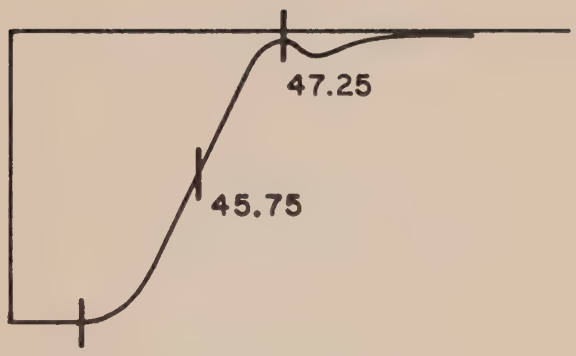


Fig. 11 Trap Alignment, Step 2

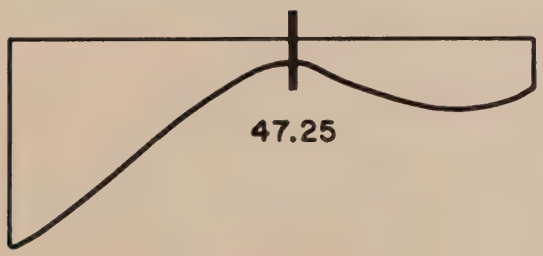


Fig. 12 Trap Alignment, Step 3

Fig. 13 Beat Indication for 47.25 MC Trap Between Marker and Sweep Outputs

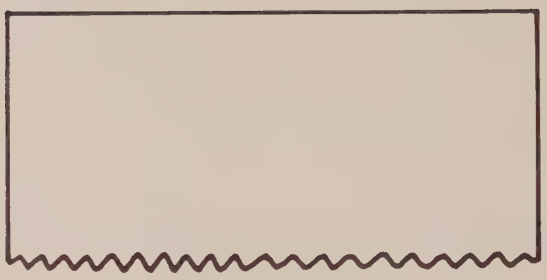


Fig. 14 Sweep Generator Output Increased

Fig. 15 Trap Tuned to Minimum Height

D. Front End Alignment

There are three major considerations in front end alignment.

A. Bandwidth of 5 to 6 mc.

B. The response curve be centered within the channel limit frequencies.

C. Maximum gain on each channel consistent with correct bandwidth.

To observe head end response curves, consult the Service Notes of the receiver for the correct take-off point in the plate circuit of the mixer tube. The curve should be taken off through an isolation resistor of about 10,000 ohms and the sweep generator signal injected through the ST-8A 300-ohm Adaptor, to the antenna terminals of the receiver. The manufacturer's instructions should be closely followed as many sets have head end interaction.

The correct local oscillator adjustment is made by tuning the Sweep Generator to cover the desired channel frequencies. The Marker Generator picture carrier crystal is turned ON, and the audio carrier marker is turned ON. The receiver output is taken from the video detector. The fine tuning control is turned to about mid-rotation. By spreading or squeezing the channel oscillator coil, place the audio marker at the correct point on the curve. The video carrier marker should then fall at the correct point of 50 percent down from maximum. At this point, check the discriminator output, the audio marker should be centered on the discriminator curve. If not, touch up the oscillator coil to center marker. Replace output to the video detector and check the fine tuning for sufficient range.

As a final test, the sweep generator output should be decreased while the oscilloscope gain is increased, until noise appears on the curve. The receiver contrast control should be at maximum gain. The over-all curve should not shape appreciably on this small signal, nor should it change as the contrast control is varied, except in height.

8. ALIGNMENT ERRORS DUE TO PHASE SHIFT

When using Visual Alignment it is necessary that the detector that provides the response curve for the scope do so with a minimum of phase shift. Excessive phase shift can cause serious errors in the placement of markers and in the actual shape of the response curve (see Fig. 16).

Fortunately it is easy to check phase shift. Merely switch OFF the Sweep Generator blanking so that the retrace response curve shows on the scope. By adjusting the Sweep Generator phasing control it should be possible to superimpose the response curves and the markers simultaneously. When using wide sweeps such as in video IF's and "head ends" it is usually not possible to superimpose the entire trace, but it will also be noted that the markers will not superimpose at this portion of the curve. See Fig. 17. This is normal and is due to slight non-linearities in the sweep.

Occasionally a condition will be found where the trace and retrace are essentially duplicates of each other but are more or less evenly displaced vertically, see Fig. 18. This is due to hum in the detector, or hum picked up by the response curve cable or isolating resistor. In general, this condition is not normal and the cause of it should be determined, (heater cathode leakage, insufficient filtering of B+, etc). It is hard to lay down any tight rules regarding hum; the amount permissible, if any has to be determined by experience with the particular type of receiver.

In rare instances it has been found that the receiver manufacturer's Service Notes specify resistor and capacitor decoupling networks that cause severe phase shift. In most cases reducing the value of the capacitor or eliminating it will correct the phase. Be sure however, that the response curve cable is "cold". Proper selection of the ground point will usually accomplish this.

The most troublesome detectors for phase shift are discriminators and ratio detectors (Fig. 19). Quite often tone control settings will affect phase shift. If the Service Notes indicate that the top of the volume control is the take-off point for a discriminator curve, it is sometimes better to move back closer to the discriminator.

In some cases it will be impossible to completely reduce the phase shift. The procedure then is to operate with blanking OFF and sweep as narrow as possible while still keeping the whole discriminator curve. If the curves are superimposed the markers will be separated and the center of the discriminator is essentially half way between the two (Figs. 20 and 21). In really bad cases the best procedure is to reduce the sweep width to zero, set it to beat with the marker, switch the Sweep Generator blanking ON and adjust discriminator crossover by superimposing the two vertically displaced lines on the scope. In this case, we are using the oscilloscope as a vacuum tube voltmeter, and the blanking of the Sweep Generator is providing a zero reference line. (See Fig. 22.)

9. IDENTIFICATION OF CHANNEL MARKERS WHEN VIEWING OVER-ALL RESPONSE CURVES OF RECEIVER

When viewing the over-all response of a receiver from antenna input to picture detector there is a possibility of becoming confused in identifying channel picture and sound markers. This is due to the tendency of some users to think in terms of IF when viewing the curve at the picture detector. When operating the Sweep Generator at IF the operator should view the curve in terms of IF markers, assuming the sweep and marker are set for the same IF. When the sweep is operated at channel frequencies the operator should view the curve and markers in terms of channel frequencies (assuming the Marker Generator is set for the same channel as the Sweep Generator). The confusion arises when the operator, thinking in IF terms, forgets to allow for the fact that in superhetrodyne circuit the receiver's local oscillator performs a frequency inversion when converting from channel to intermediate frequencies. This frequency inversion takes place if the receiver's local oscillator operates on the high side of the

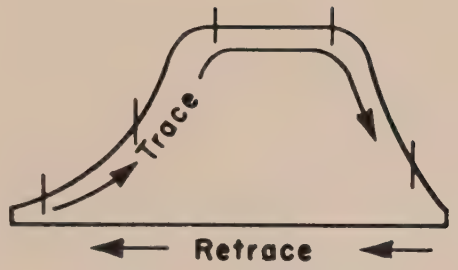


Fig. 16 Typical response curve with Sweep blanking ON. Retrace curve and markers blanked out - no RF output during retrace period - retrace is a straight, horizontal line back to the starting point.

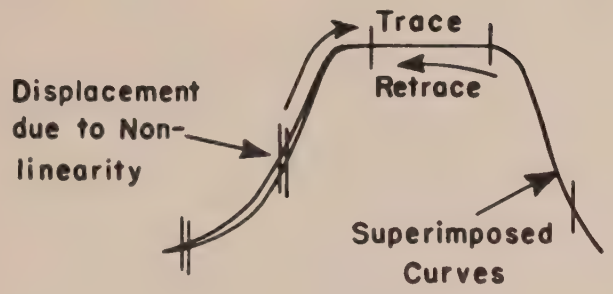


Fig. 17 Same curve as Fig. 16 with Sweep blanking OFF. Retrace curve and markers superimposed on right hand side - slight displacement on left side. If phaser on Sweep is adjusted to superimpose left side, then the right hand side will be slightly displaced. This is to be considered as a normal curve. The detector's phase response is adequate for visual alignment.

Fig. 18 Same curve as Fig. 17 except that the retrace curve is displaced vertically due to hum. In general this is an abnormal condition and should be corrected. Check for: hum pickup by Response Curve Cable, heater cathode leakage, B+ filtering, etc. The exception is: when viewing "head end" response at the converter plate it may not be possible to reduce the hum completely. Try feeding B+ to the "head end" through 100-ohm 1-watt resistor and temporarily connect 200 to 500 uf of electrolytic capacitor from "head end" B+ to B-.

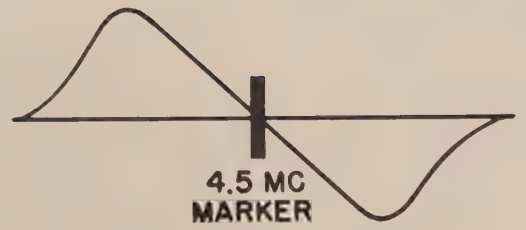


Fig. 19 Typical discriminator curve. Sweep Generator blanking ON. This presentation can be used if phase shift is negligible.

Fig. 20 Same curve as Fig. 19, except Sweep Generator blanking OFF. Excessive phase shift, discriminator curves superimposed, marker displaced.

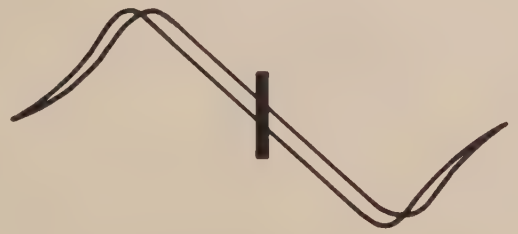
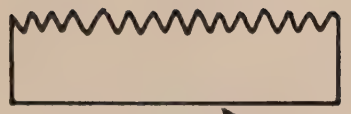
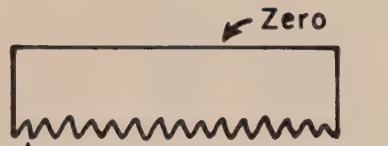


Fig. 21 Same curve as Fig. 19, except marker superimposed and discriminator curves displaced. Either Fig. 19 or 20 can be used for alignment except that crossover is best adjusted with zero sweep width.



A

A. Adjusting discriminator crossover. Sweep width zero, Sweep Generator blanking ON. Discriminator is on ± side of zero.



B

B. Same as A, except the discriminator is on minus side of zero.

C

C. Same as A, except that discriminator is on zero. Note: A very slight adjustment of the discriminator should produce either A or B. That is, the condition for C is a critical adjustment between A and B.

Fig. 22 Adjusting Discriminator Crossover

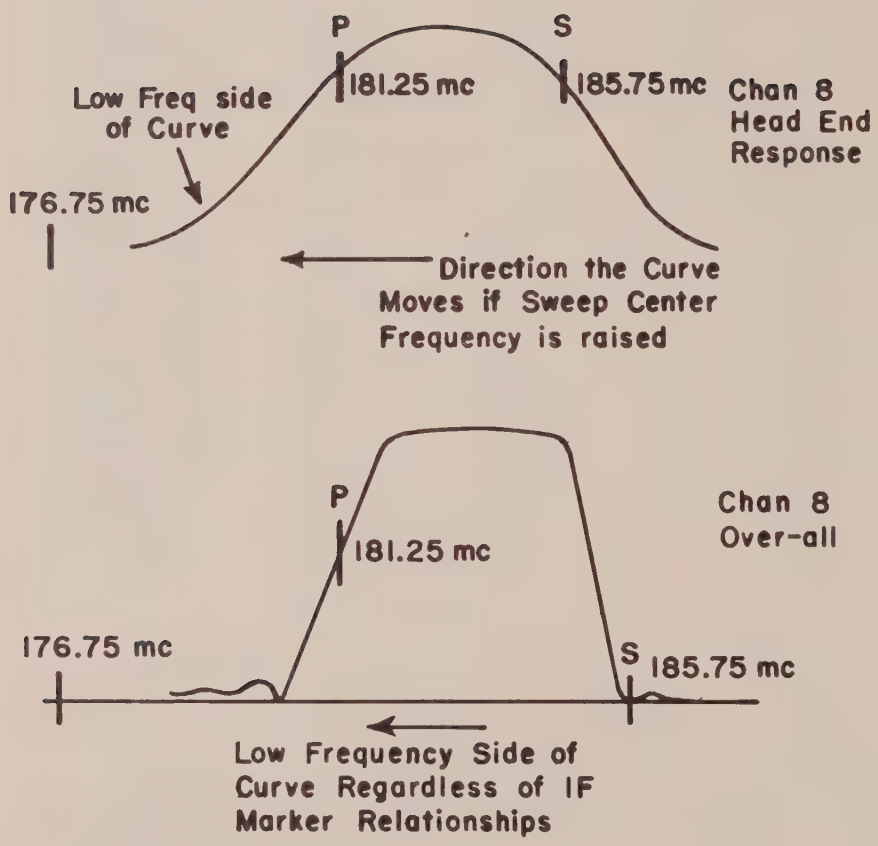


Fig. 23 Locating the Low-Frequency Side of the Response Curve

incoming signal. Most television receivers operate with the oscillator high. However, some television sets are operated with the oscillator high on the low channels and low on the high channels. This of course should lead to even worse confusion if the operator insists on thinking IF when working with television channels.

Remember the following:

A. On the present channels the sound is always higher in frequency than the picture. This is fixed by the FCC.

B. At IF the sound may be higher or lower than the picture, depending on how the receiver's local oscillator is operated.

C. When operating the Sweep and Marker at channel frequencies, keep in mind the channel frequencies and channel relationships between the picture, sound, and adjacent channel carriers, and their relationship to the L.O. frequency.

In visual alignment procedures it is conventional to place the low-frequency side of the displayed curve to the left side of the oscilloscope. Due to the fact that the Sweep Generator has facilities for changing the phase of the oscilloscope horizontal sweep voltage more than 360 degrees, the response curve can be reversed.

The following procedure will establish which side of the displayed curve is the low-frequency side. (See Fig. 23.)

A. Tune the Sweep Generator to a slightly higher frequency.

B. Observe the direction of movement of the response curve. It will move toward the low-frequency side.

C. If the curve is reversed (low frequency at the right), turn the PHASE REVERSAL switch on the Sweep Generator and recenter curve.

This is true regardless of how we are viewing the curve, i.e., IF, "head end", or over-all antenna to picture or audio detector, providing the operator will remember to think in terms of the frequency the Sweep Generator is delivering. For example, when viewing over-all response from the antenna to the picture detector on channel 8, the sweep is set for channel 8 (180-186 mc) with the markers at 181.25 picture and 185.75 mc sound. Another marker will show at 176.75 mc if the sweep is wide enough. This is simply the other 4.5 mc sideband of 181.25. Regardless of whether we view the resulting response curve at the "head end" on picture detector the frequencies are the same for alignment purposes. See Fig. 23.

By carrying out the superhetrodyne conversion for Fig. 23 on paper we see how the confusion occurs when trying to think in terms of IF while working with channel frequencies. In this typical receiver the local oscillator operates 45.75 mc above the incoming signal, for channel 8 we would have the following:

Local Oscillator	227.00 mc	Local Oscillator	227.00 mc
Channel 8 Pix Carrier	181.25 mc low	Channel 8 Soundcar	185.75 mc high
IF Picture Carrier	45.75 mc high	IF Soundcar	41.25 low

It can be seen that in terms of IF the curve is the reverse of what it is for channels when the oscillator is on the high side. It can also be seen that its a lot easier to forget about IF and think only in terms of channel frequencies and carrier relationships when working on channels.

10. USING THE SWEEP AND MARKER GENERATORS ON UHF TELEVISION CHANNELS

When the ST-4A and ST-5A were first introduced to the trade it was felt that they would not be suitable for UHF. This was based on the fact that we had no accurate measurements or practical experience with them in the UHF region. Lacking this information it seemed logical to believe that the attenuator would have resonances in the UHF region and the harmonic output of the sweep would be too low to be useful. Subsequent measurements and experience in the UHF region indicate that we were wrong. The attenuator is satisfactory except that near the minimum setting of the "fine" attenuator, the output starts to increase instead of decrease. However, if the operator will reduce the output by coming down a step on the decade attenuator it will be found that good control of the signal is possible and no AM due to the attenuator will be present. Harmonic output varies, depending on harmonic order and sweep generators, from approximate 2000 microvolts to 50,000 microvolts.

Some examples are given:

550 mc	Gen #1,	13,000 microvolts	3rd harmonic
	Gen #2,	18,000 microvolts	of 183 mc
660 mc	Gen #1,	28,000 microvolts	3rd harmonic
	Gen #2,	45,000 microvolts	of 220 mc
660 mc	Gen #1,	10,000 microvolts	4th harmonic
	Gen #2,	no figures	of 165 mc
735 mc	Gen #1,	2100 microvolts	4th harmonic
	Gen #2,	3000 microvolts	of 188 mc

A. Using The ST-4A Sweep Generator At UHF

For UHF the direct harmonics of the swept oscillator only are used. The beat oscillator is switched OFF. Available coverage is from 495 to 1100 mc as follows:

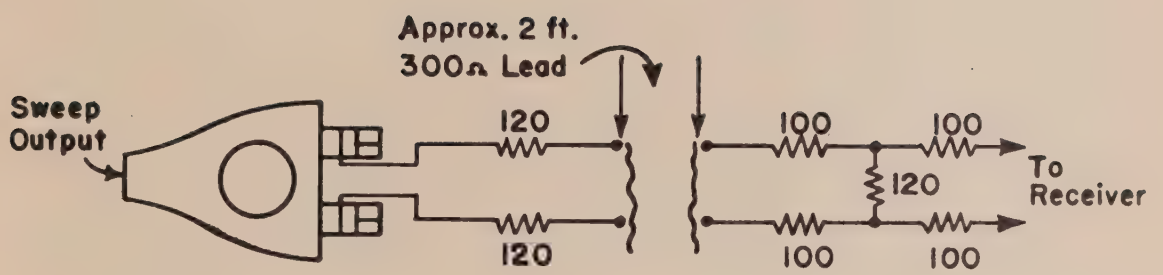
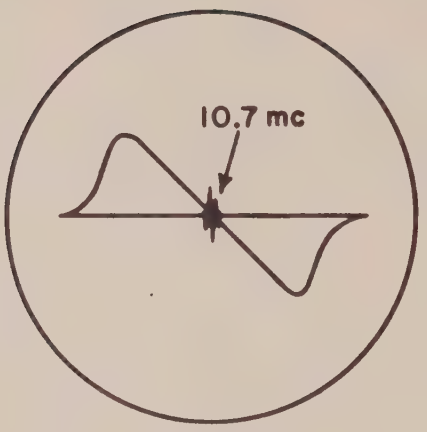
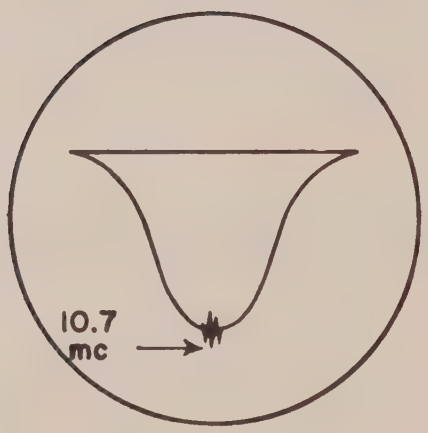


Fig. 24 UHF Termination of Sweep Generator



A DISCRIMINATOR CURVE



B IF CURVE
(This curve steepens as more stages are added)

Fig. 25 Alignment Curves for AM-FM Receiver, Model 417A

495 to 660 mc - 3rd harmonic 165 to 220 mc

660 to 880 mc - 4th harmonic 165 to 220 mc

825 to 1100 mc - 5th harmonic 165 to 220 mc

It should be remembered that sweep width is multiplied directly by the harmonic order used, i.e., a sweep width of 15 mc on a fundamental of 165 mc would be 60 mc wide at the 4th harmonic of 660 mc. Consequently sweep width settings will be generally lower when working in the UHF band. The proposed channel bandwidth for black and white in the UHF region are 6 mc wide just as they are for the present UHF channels.

The Balanced Output Adapter, ST-8A, should not be used for UHF. The best method we have found for connecting the sweep to the input of a UHF convertor or receiver is as sketched on Fig. 24, using the single ended output cable (Fig. 24). This method produces reasonably cool cables (low standing wave ratio).

B. Using The ST-5A Marker Generator At UHF

The Marker Generator can be used in conjunction with the ST-4A Sweep to provide a single marker in the UHF band. Using sideband markers is confusing because the sweep harmonics are being used and consequently a 1.5 mc marker would not be 1.5 mc away from the main marker. Instead it would be the sweep's harmonic order times 1.5 mc. For example; if the 4th harmonic of the sweep were being used in the 700 mc region a 1.5 mc marker would actually be 6 mc separated from the main marker in the 700 mc region.

To produce a single marker - such as the picture carrier - in the UHF channels proceed as follows:

1) Divide the desired frequency by the harmonic order of this sweep generator.

2) Divide this figure by 4 or 5 (in general use 4 if the figure is under 200 mc). Set the marker's tunable oscillator to this frequency and adjust marker size as desired. As an example; Station KC2XAK in Bridgeport, Conn.

Frequency 529 to 535 mc (sweep 3rd harmonic)

Picture carrier - 530.25 mc

Want marker for picture carrier

$\frac{530.25}{3} = 176.75$ mc (3 is harmonic order of sweep)

$\frac{176.75}{4} = 44.1875$ mc

Set the marker's oscillator for the 37-50 mc band and adjust to 44.1875 mc - actually it would be set so that the pointer is against the low side of the 44.2 mark. In fact if the dial is set to 44.2 mc, the marker will be accurate to approximately 0.03 percent (0.0003).

C. Spurious Responses

Signal output from the Sweep Generator will only be submultiples and multiples of the desired frequency as well as the desired frequency. Therefore, if the receiver were a TRF job instead of a superhet there would be no spurious responses. TV receivers in general are superhets and therefore subject to spurious responses. These responses will depend on the various receivers and converters. In general they are more troublesome with UHF converters and double conversion receivers. Keeping the sweep width down to about 12 to 15 mc and using a marker will minimize spurious response difficulties.

D. Conclusions

Although not specifically designed for the UHF channels the ST-4A and ST-5A Sweep and Marker Generators perform remarkably well in the UHF region. TV service organizations owning these equipments are assured that they will be equipped to handle any UHF channels that come on the air in their area.

11. ALIGNMENT OF A TELEVISION RECEIVER

The sweep technique, as outlined above, is the accepted method for aligning the IF and video circuits involved in any television receiver. However, because of variations in receiver design, no specific alignment procedure can be given which will be applicable to more than a small fraction of those sets normally encountered in service work. The service man is therefore advised to obtain service notes for any specific receiver either from the manufacturer of the set or from some commercial source.

Complete alignment procedures for G-E receivers are given in the General Electric Service Date booklets of the ER-S series. These booklets are available under the model number of the receiver, and may be obtained from the General Electric Company, Receiver Department, Electronics Park, Syracuse, N.Y.

12. ALIGNMENT OF AN FM RECEIVER

As in the case of the television receiver, the FM receiver has a circuit that requires a Sweep Generator for proper alignment.

There are several types of circuit utilized in the design of FM receivers and the operator is referred to the Service Notes of the particular receiver for its peculiarities.

The following pages give an alignment of a General Electric Model 417 AM-FM receiver. The alignment assumes that the receiver has no defects

other than misalignment. The Model 417 receiver uses a limiter-discriminator type of circuit for demodulation purposes.

The sequence of adjustment on the Model 417 receiver is as follows:

1) FM IF Alignment

2) AM IF Alignment

3) FM RF Alignment

4) SW RF Alignment

5) Broadcast RF Alignment

Page 10 outlines the method of securing 10.7 mc output from the ST-4A Sweep Generator. Since the marker output of the ST-5A Marker Generator does not include frequencies as low as 10.7 mcs, some substitute marker pips can be provided.

Using the calibration procedure outlined, zero the Marker Generator scale with its crystal at the 22.5 mc point. Now tune the generator to 21.4 mcs. Controls are set as follows:

PICTURE CARRIER selector switch	-	20-27 mc
PICTURE CARRIER switch	-	on
POWER switch	-	on
MARKER SIZE control	-	as needed
CRYSTAL MODULATOR switch	-	off
RESPONSE FROM RECEIVER attenuator switch	-	as needed

Using the information on page 10, tune the Sweep Generator until the marker appears to be in the center of the sweep on the oscilloscope. This marker is produced by 21.4 mcs output beating against the second harmonic of the Sweep Generator.

IF ALIGNMENT TABLE FOR GENERAL ELECTRIC RECEIVER, MODEL 417A

Step No.	Generator Setting	Signal Input	Oscilloscope	Receiver Selector Dial		Remarks
1	10.7 mc 2 mc sweep	Grid of V6 (Limiter) thru 0.01 mfd	Across C34 thru 250 k	FM1	-	Adjust C48 for max. output, and C49 for straightest line. Marker centered on curve. See Fig. 25A.
2	10.7 mc 2 mc sweep	Grid of V5	Grid of V6 thru 250 k	FM1	-	Adjust C94 and C28 for best curve. See Fig. 25B. Remove V7.
3	10.7 mc 2 mc sweep	Grid of V4	Grid of V6 thru 250 k	FM1	-	Adjust C93 and C26 for best curve.
4	10.7 mc 2 mc sweep	Grid of V2	Grid of V6 thru 250 k	FM1	-	Adjust C24 and L10 for best curve.
5	AM Generator 455 kc with 400 cycle mod.	Grid of V2	Grid of V6 thru 250 k	Std.	-	Adjust C86 and C61 for max. output.
6	AM Generator 455 kc with 400 cycle mod.	Grid of V2	Grid of V6 thru 250 k	Std.	-	Adjust C15 and C23 for max. output.
7	AM Generator 455 kc with 400 cycle mod.	Grid of V2	Grid of V6 thru 250 k	Std.	-	Adjust C13 and C14 for max. output.

RF ALIGNMENT TABLE FOR GENERAL ELECTRIC
RECEIVER, MODEL 417A

Step No.	Generator Setting	Signal Input	Oscilloscope	Receiver Selector	Dial	Remarks
8	88 mc with 2 mc sweep 88 mc marker	Dipole Term. with ST-8A	Grid of V6 thru 250 k	FM2	88*	Adjust C6 for best curve with centered marker. See page 11 for marker settings.
9	98 mc with 2 mc sweep 98 mc marker	Dipole Term. ST-8A	Grid of V6 thru 250 k	FM2	98	Tune for max. curve then peak C3 for best curve.
10	98 mc with 2 mc sweep 98 mc marker	Dipole Term. with ST-8A	Grid of V6 thru 250 k	FM2	98	Adjust C2 for best curve.
11	43 mc with 2 mc sweep 43 mc marker	Dipole Term. with ST-8A	Grid of V6 thru 250 k	FM1	43**	Set dial accurately, then adjust C45 for centered marker.
12	46 mc with 2 mc sweep 46 mc marker	Dipole Term. with ST-8A	Grid of V6 thru 250 k	FM1	46	Tune dial for max. curve then set C63 for max.
13	46 mc with 2 mc sweep 46 mc marker	Dipole Term. with ST-8A	Grid of V6 thru 250 k	FM1	46	Tune C65 for max. curve.

*If no dial scale is available, turn pointer to extreme right limit. Make a reference mark, then measure to the left 6.8 inches.

**If no dial scale available, turn back to reference mark and measure to the left 6 inches.

SW AND BROADCAST RF ALIGNMENT TABLE FOR
GENERAL ELECTRIC RECEIVER, MODEL 417A

Step No.	Generator Setting	Signal Input	Oscilloscope	Receiver Selector	Dial	Remarks
14	AM generator 11.8 mc	Antenna thru 400 ohm	Across voice coil of spkr. Turn up volume	SW2	11.8*	Set C58 for max. output.
15	AM generator 11.8 mc	Antenna thru 400 ohm	Across voice coil of spkr. Turn up volume	SW2	11.8*	Peak C57 while rocking dial slightly.
16	AM generator 11.8 mc	Antenna thru 400 ohm	Across voice coil of spkr. Turn up volume	SW2	11.8*	Peak C54 located on the back apron of chassis.
17	Generator at 9.6 mc	Antenna thru 400 ohm	Across voice coil of spkr. Turn up volume	SW1	9.6 mc**	Adjust C59 for max. output.
18	Generator at 9.6 mc	Antenna thru 400 ohm	Across voice coil of spkr. Turn up volume	SW1	9.6 mc**	Peak C56 while rocking dial slightly.
19	Generator at 9.6 mc	Antenna thru 400 ohm	Across voice coil of spkr. Turn up volume	SW1	9.6 mc**	Peak C55.

*11.8 mc on the dial can be positioned by measuring 4.5 inches from the reference mark previously made.

**9.6 mc is located in the same spot as 11.8 mc.

SW AND BROADCAST RF ALIGNMENT TABLE FOR
GENERAL ELECTRIC RECEIVER, MODEL 417A

Step No.	Generator Setting	Signal Input	Oscilloscope	Receiver Selector	Dial	Remarks
20	1620 kc	Antenna thru 200 mmf	Across voice coil of spkr. Turn up volume	Std.	Extreme right	Peak C5.
21	1620 kc	Antenna thru 200 mmf	Across voice coil of spkr. Turn up volume	Std.	Extreme right	Peak C4.
22	1620 kc	Antenna thru 200 mmf	Across voice coil of spkr. Turn up volume	Std.	Extreme right	Peak C1.
23	1500 kc	Antenna thru 200 mmf	Across voice coil of spkr. Turn up volume	Std.	1500 kc*	Adjust iron core of T3 for max. (oscillator)
24	1000 kc	Antenna thru 200 mmf	Across voice coil of spkr. Turn up volume	Std.	Tune for max.	Adjust core of T6 for max. (converter)
25	1000 kc	Antenna thru 200 mmf	Across voice coil of spkr. Turn up volume	Std.	Tune for max.	Adjust core of T1 for max. (RF)
26	580 kc	Antenna thru 200 mmf	Across voice coil of spkr. Turn up volume	Std.	Tune for max.	Adjust L8 while rocking dial.
27	Repeat Broadcast alignment steps.					

*1500 kc is 1.5 inches to the left of the dial reference line.

MAINTENANCE

1. REMOVING TUBES

The two oscillator tubes, V1 and V3, and the mixer tube, V2, are located in a shielded oscillator compartment. The generator is first removed from its case and inverted. Removing the shield from the oscillator compartment exposes the tubes for testing or replacement.

2. OPERATION ON 230 VOLTS (See Fig. 26)

The power transformer of the ST-4A Sweep Generator has two primary windings which are wired in parallel for 117-volt operation at the factory (Fig. 26A.)

If the generator is to be used on 230-volt power, Fig. 26B shows the simple change to be made.

3. ERRATIC GENERATOR OUTPUT

The appearance of the band pass of a typical television front end is shown on Fig. 27A. If the SWEPT OSC tube is low in output, the oscilloscope will show a condition similar to Fig. 27B. This is due to the fact that the oscillator ceases oscillation abruptly at certain frequencies rather than producing a lower output. Normal operation is restored by inserting a new tube in the circuit.

4. CHECKING THE OUTPUT OF THE SWEPT OSCILLATOR

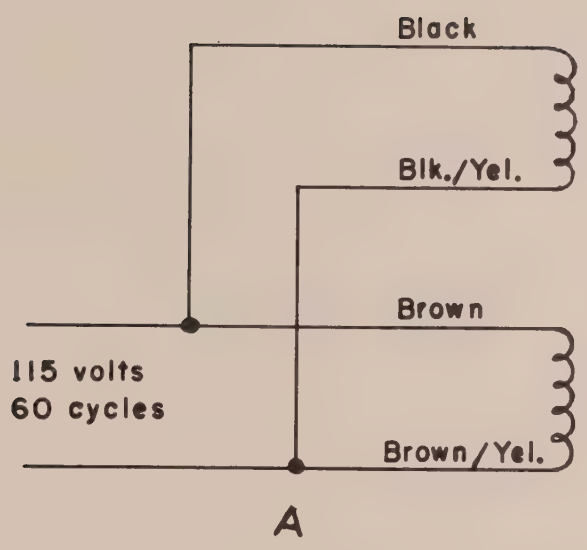
The SWEPT OSC can be checked for output by turning the BEAT OSC switch OFF, then checking at the RF Output X1 jack with a vacuum tube voltmeter. Reading should be from 1 to 3 volts, with no sweep.

5. CHECKING THE CW OSCILLATOR

The CW OSCILLATOR output can be checked by switching the SWEPT OSC OFF and reading output at X1 output jack with a vacuum tube voltmeter. Reading should be 0.5 to 1.5 volts, with no sweep.

6. CHECKING THE RF ATTENUATOR

The resistance from each output jack to ground, as measured with an ohmmeter, should be 100 ohms, $\pm$ 5 percent. If the attenuator assembly should become defective, it should be replaced completely to preserve its accuracy. A complete assembly is available as a replacement part.



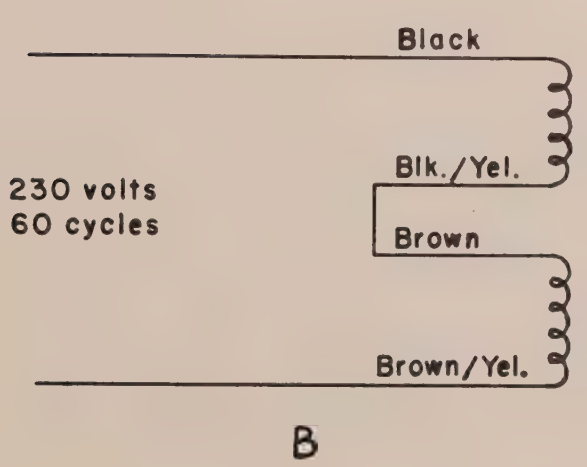


Fig. 26 Changes for 230-Volt Operation

A

Normal Appearance of
Receiver Pass Band

B

Defective Swept
Oscillator Tube

Fig. 27 Effect of Defective Oscillator Tube

7. CHECKING FOR PLATE VOLTAGE

The operator can check quickly for the presence of B+ without removing the case or cover by checking at the two upright load resistors on the chassis to ground. The largest resistor is R26, and the other is R27. With BLANKING OFF, no sweep and both oscillators off, the voltages should be as follows:

A.	Junction of R26 and R27	285 volts d-c
B.	Bottom of R26 Rotating sweep width control 0-300 a-c in 7 steps (Elementary Diagram for voltages)	70 volts d-c
C.	Turning CW oscillator ON junction of R26 and R27	250 volts
D.	Turning both oscillators ON	210 volts

8. CHECKING SWEEP WIDTH

The exact sweep width of the generator can be checked easily with the aid of the Marker Generator, ST-5A.

Connect the Sweep Generator, Marker Generator, and Oscilloscope as on Fig. 5.

A. Set the Sweep Generator to some convenient center frequency as 35 mc.

B. Calibrate Marker Generator to 36 mc. Now turn the Marker Generator dial until pip just disappears at one end of the sweep trace on the oscilloscope and take reading. Turn the Marker Generator dial back until the pip just disappears at the other end of the displayed trace. Take reading.

C. The difference between the first and second readings is the sweep width. The same procedure is followed on all sweep widths.

In the event that the ST-5A Marker Generator is not available, the sweep width can be calculated with an ordinary signal generator. In this case, the accuracy of the calculation is limited to the calibration tolerance of the generator used.

The outputs of the Sweep Generator and the signal generator are fed to a crystal detector whose output is connected to the oscilloscope. As the signal generator is tuned to the high end of the sweep display, a pip will move on the trace. Take the generator reading at the high-frequency end and tune to the low end. The difference between the two readings is the sweep width.

9. REPLACEMENT OF SWEEP REACTOR, L1

The sweep reactor, L1, is uncovered by removing the instrument case cover, and the two oscillator shield cover plates. L1 is the reactor mounted on the sidewall with Textolite* supports.

Unsolder the bus wires from the two terminals and loosen the 4 set screws with an Allen wrench. Gently pry loose the core lamination from the Textolite* supports. Lift L1 vertically.

When replacing L1, be sure that oscillator coil L4 is centered between the pole pieces of L1 since L4 carries 150 volts d-c to V1.

10. OPERATION WITHOUT AM COMPENSATION NETWORK

In case of failure of T2, the entire corrective network may be disconnected and a wire connected in to restore plate voltage to V2. For ordinary servicing operations the amount of amplitude modulation will not be noticeable.

SOCKET VOLTAGE DATA

All voltages measured from pin to ground, except where noted, with a vacuum tube voltmeter. Blanking OFF, Sweep OFF, both oscillators ON, swept oscillator 200-mc and beat oscillator-250 mc. V4 voltages measured with 1000 ohm/volt voltmeter.

V1 6J6
Swept Oscillator

Pin	
1.	125 v
2.	Tied to #1
3.	6.3 v a-c
4.	Ground
5.	-9 v
6.	Tied to #5
7.	Ground

V2 6J6
Mixer

Pin	
1.	130 v
2.	Tied to #1
3.	6.3 v a-c
4.	Ground
5.	-8.8 v
6.	-15 v
7.	Ground

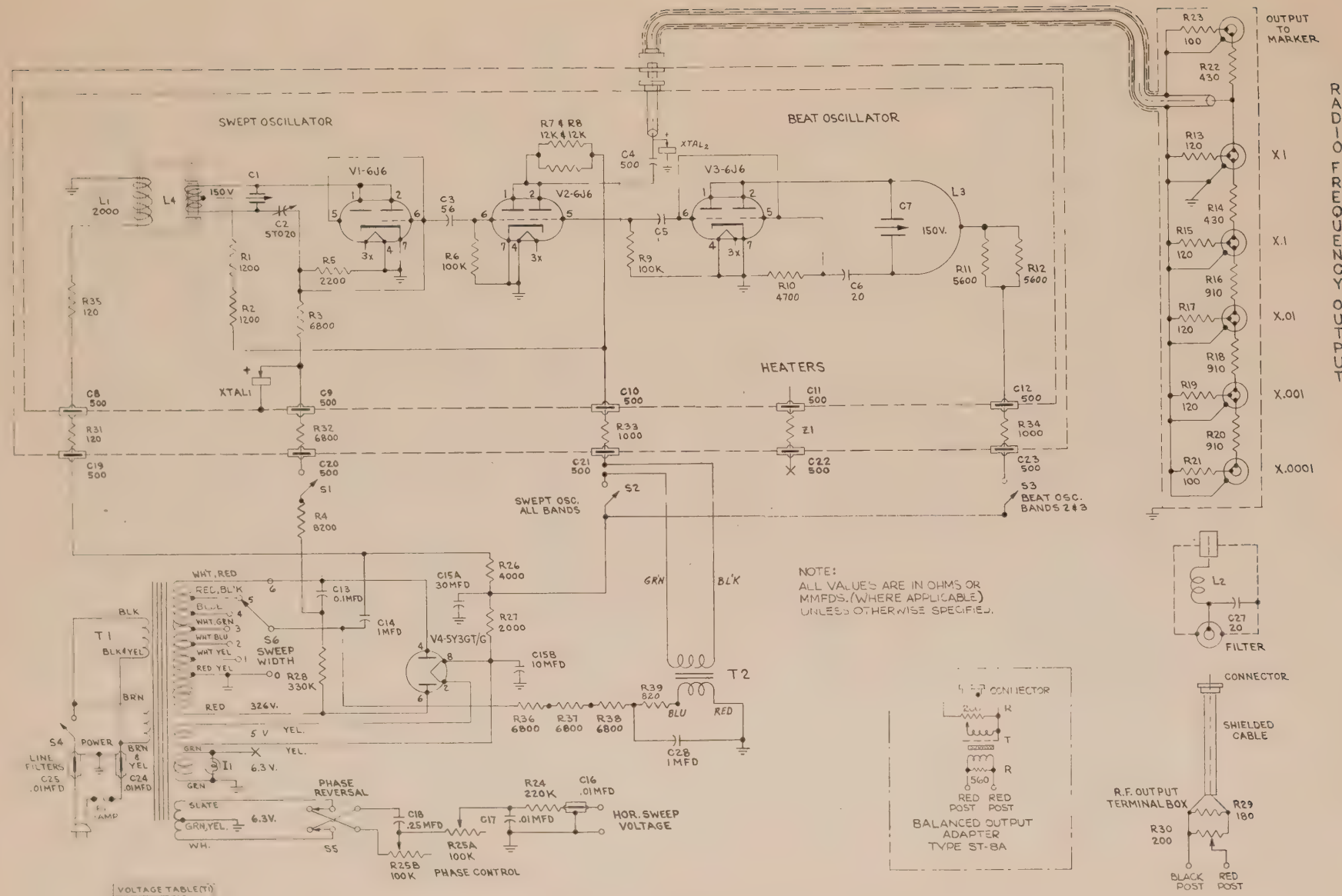
V3 6J6
Beat Oscillator

1.	145 v
2.	Tied to #1
3.	6.3 v a-c
4.	Ground
5.	-6.8 v
6.	-7 v
7.	Ground

V4 5Y3GT
Rectifier

1.	310 v a-c
2.	5 v a-c**, 290 v
3.	300 v a-c
4.	310 v a-c
5.	NC
6.	310 v a-c
7.	NC
8.	5 v a-c**, 290 v

*Registered General Electric Trade Mark.
**Measured between pins 2 and 8.



VOLTAGE TABLE(1)

POSITION	LOAD
0-1	8 V
0-2	7 V
0-3	81 V
0-4	163 V
0-5	244 V
0-6	326 V

Fig. 28 Elementary Diagram, ST-4A Sweep Generator (W-106J48, Rev. 9)

PARTS LIST

This list includes all principal replacement parts. The symbol numbers used are the same as those appearing on elementary and other diagrams. When ordering a replacement part, please include description, symbol designation, and reference number of the part and model number of the equipment. Orders may be sent to the nearest General Electric office or to the General Electric Company, Commercial and Government Equipment Department, Electronics Division, Syracuse, N. Y.

Symbol	Description	G-E Drawing
	CAPACITORS	
C1	Variable, air, 2.7 to 22.5 mmfd. Hammarlund Cat. #VU-20 with L4 added.	M-103J288-P1
C2	Variable, ceramic, 5 to 20 mmfd, 500 v d-c w. Erie Type TS2A-N300.	M-7484389-P4
C3	Ceramic, 56 mmfd ± 10%, 500 v d-c w, -750 temp coef.	P-3R93-P132
C4	Mica, button type, 470 mmfd ± 10% at 1 mc, 500 v d-c w. Erie Type 370CB.	M-7471350-P10
*C5	Ceramic, 10 mmfd ± 0.5 mmfd, 500 v d-c w. Erie Style 331.	P-7772744-P10
C6	Silver mica, 20 mmfd ± 5% at 1 mc, 500 v d-c w. Erie Type 370 FA.	M-7480249-P11
C7	Variable, air, 3 to 8.5 mmfd. Bud Radio Cat. #20101.	M-103J524-P1
C8 thru C12	Mica, button type, 470 mmfd ± 10% at 1 mc, 500 v d-c w. Erie Type 370 CB.	M-7471350-P10
C13	Paper, 0.10 mfd ± 10%, 600 v d-c w.	M-103J700-P23
C14	/Pyranol, 1.0 mfd ± 10%, 600 v d-c w. G-E Cat. #23F467.	P-3R144-P8

*This item or equivalent should be obtained from a local radio dealer.
/Registered U.S.Patent Office.

Symbol	Description	G-E Drawing
	CAPACITORS (CONTINUED)	
C15	Electrolytic, 10-30 mfd +50% -10%, 450 v d-c w.	K-113J453-P1
C16	Paper, 0.01 mfd +20% -10%, 600 v d-c w. Sprague Cat. #47P6.	M-7479126-P4
C17	Paper, 0.01 mfd ± 20%, 400 v d-c w.	M-103J789-P1
C18	Paper, 0.25 mfd +20% -10%, 400 v d-c w.	M-103J789-P6
C19 thru C23	Mica, button type, 470 mmfd ±10% at 1 mc, 500 v d-c w. Erie Type 370 CB.	M-7471350-P10
C24 and C25	Paper, 0.01 mfd +20% -10%, 600 v d-c w. Sprague Cat. #47P6.	M-7479126-P4
C27	Silver mica, 20 mmfd ± 5% at 1 mc, 500 v d-c w. Erie Type 370FA.	M-7480249-P11
C28	Paper, 1.0 mfd ± 10%, 200 v d-c w.	M-103J859-P16
	FUSES	
F1	1 amp, 250 v, Type 3AG, slow blow. Littelfuse Cat. #313001, Bussman Cat. #MDL-1.	M-7478924-P9
	INDICATING DEVICES	
*I1	Lamp: 6-8 v, 0.25 amp, miniature bayonet base. G-E Cat. #44.	
	INDUCTORS	
L1	Reactor: d-c resistance 2000 ohms ± 12%.	K-113J578-P1
L2	Choke: 8 turns 3/16" ID of 0.032 ID insulated copper wire.	K-112J3-P1
L3	Coil: 0.064" dia copper wire.	
L4	Loop of 0.040" ID insulated copper wire. Included with C1.	

*This item or equivalent should be obtained from a local radio dealer.

Symbol	Description	G-E Drawing
	RESISTORS	
*R1 and R2	Composition, 1200 ohms ± 10%, 2 w. Jan Type RC42BF122K.	
*R3	Composition, 6800 ohms ± 10%, 2 w. Jan Type RC42BF682K.	
*R4	Composition, 8200 ohms ± 10%, 2 w. Jan Type RC42BF822K.	
*R5	Composition, 2200 ohms ± 10%, 1 w. Jan Type RC30BF222K.	
*R6	Composition, 0.10 megohm ± 10%, 1/2 w. Jan Type RC20BF104K.	
*R7 and R8	Composition, 12,000 ohms ± 10%, 2 w. Jan Type RC42BF123K.	
*R9	Composition, 0.10 megohm ± 10%, 1/2 w. Jan Type RC20BF104K.	
*R10	Composition, 4700 ohms ± 10%, 1 w. Jan Type RC30BF472K.	
*R11 and R12	Composition, 5600 ohms ± 10%, 2 w. Jan Type RC42BF562K.	
R13 thru R23	Attenuator assembly.	ML-103J537-G1
*R24	Composition, 0.22 megohm ± 10%, 1/2 w. Jan Type RC20BF224K.	
R25	Potentiometer, composition, dual: each section rated 100,000 ohms ± 20%, 1/4 w, front section linear taper, rear section log taper. Mallory Type LC.	K-102J967-P1
R26	Wirewound, 4000 ohms ± 5%, 50 w. Ward Leonard Cat. #K41389-2.	M-2R17-P107

*This item or equivalent should be obtained from a local radio dealer.

Symbol	Description	G-E Drawing
	RESISTORS (CONTINUED)	
R27	Wirewound, 2000 ohms ± 5%, 25 w. Ward Leonard Cat. #K41383-2.	M-2R14-P84
*R28	Composition, 0.33 megohm ± 10%, 2 w. Jan Type RC42BF334K.	
R29	Composition, 180 ohms ± 5%, 1/2 w. Jan Type RC20BF181J.	
R30	Potentiometer, composition: 200 ohms ± 20%, 1/4 w, linear taper. Centralab Model E or Model 2.	K-102J978-P1
*R31	Composition, 120 ohms ± 10%, 1 w. Jan Type RC30BF121K.	
*R32	Composition, 6800 ohms ± 10%, 2 w. Jan Type RC42BF682K.	
*R33 and R34	Composition, 1000 ohms ± 10%, 1 w. Jan Type RC30BF102K.	
*R35	Composition, 120 ohms ± 10%, 1 w. Jan Type RC30BF121K.	
*R36 thru R38	Composition, 6800 ohms ± 10%, 2 w. Jan Type RC42BF682K.	
*R39	Composition, 820 ohms ± 10%, 1/2 w. Jan Type RC20BF821K.	
	SWITCHES	
*S1 thru S4	Toggle switches: spst, 3 amp at 250 v. Arrow Hart and Hegeman Cat. #20994-WJB.	M-7478623-P1
*S5	Toggle switch: dpdt, 1 amp at 250 v, 3 amp at 125 v. Arrow Hart and Hegeman Type 20905-WJB.	M-7478623-P4
S6	Rotary tap switch: 7 positions, sp, nonshorting type; rating 150 v, 10 amp a-c. Ohmite Type 111.	K-113J582-P1

*This item or equivalent should be obtained from a local radio dealer.

Symbol	Description	G-E Drawing
	TRANSFORMERS	
T1	Pri: 117 v parallel winding, 50/60 cycles; secondaries: 5 v, 2 amp; 6.3 v, 2 amp; 326/244/163/81.5/32.6/8.15 v, 160 ma.	M-103J353-P1
T2	Hybrid transformer. Pri imp: 7700 ohms. sec imp: 600/300 ohms.	B-7485548-P1
	TUBES	
V1 thru V3	Type 6J6.	
V4	Type 5Y3GT/G.	
	CRYSTALS	
XTAL1	Germanium diode. G-E Type 1N63.	
XTAL2	G-E Type G6-A.	K-112J684-P2
	RF CHOKE COIL	
*Z1	Inductance 0.84 uh, current capacity 1000 ma, freq. range 160-350. Ohmite Cat. #Z-235.	P-7772834-P6
	MISCELLANEOUS PARTS	
	Balanced Output Adaptor, 300-ohm. (accessory)	4ST8A1
	Cable assembly, output. Includes R29 and R30.	ML-103J535-G1
	Connector, oscillator shield output.	M-7481269-P1
	Connector, female, output filter.	K-113J797-P1
	Connector, male, output filter.	K-112J1-P1
	Core, sweep reactor.	K-113J615-P1

*This item or equivalent should be obtained from a local radio dealer.

Symbol	Description	G-E Drawing
	MISCELLANEOUS PARTS (CONTINUED)	
	Coupling, condenser. National Type TX-10.	
	Dial.	M-103J540-P1
	Dial light assembly, smooth, frosted back, ruby jewel. Drake Type 40.	
	Dial mechanism.	K-102J968-P1
	Filter, output. Includes C27 and L2.	ML-112J2G1
	Foot, rubber.	K-7117972-P1
	Knob, phase control, large.	K-113J400-P2
	Knob, phase control, small.	M-103J445-P1
	Knob, sweep width.	K-7003094-P4
	Knob, tuning dial.	K-7003094-P3
	Panel, aluminum.	NP-136195
	Pointer.	K-113J764-P2
	Post, binding.	K-107J146-P1
	Window.	M-103J541-P1

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